OPERATING INSTRUCTIONS

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1570-AS15

TYPE 1570-AS15 AUTOMATIC LINE-VOLTAGE REGULATOR

. . . . SINCE 1915
manufacturers of
electronic apparatus
for science and industry

GENERAL RADIO COMPANY
CAMBRIDGE 39, MASSACHUSETTS, USA

CONDENSED CONNECTION DATA

The following table is presented for quick reference and should be consulted only after a thorough understanding of the instrument has been gained by reading the operating instructions.

INPUT (unregulated)	CONNECTION	REGULATORS REQUIRED	FUSES REQUIRED		OUTPUT	PARAGRAPH REFERENCE	FIGURE REFERENCE
			INPUT	OUTPUT			
115 v	Normal	1570-ALS15 (1)	60 amp	50 amp	115 v reg	3.2	4
230 v balanced 3-wire	Normal	1570-AHS15 (1)	25 amp (2)	20 amp (2)	230 v reg	3.2	5
230 v unbalanced 2-wire	Similar to 230-v Wye	1570-AHS15† (1)	25 amp	20 amp	230 v reg	3.6.1	4
230 v balanced 3-wire	One side regulated	1570-ALS15 (1)	60 amp (2)	50 amp (2)	115 v reg 115 v unreg 230 v unreg	3.3	6
230 v balanced 3-wire	Both sides & line-to-line reg	1570-ALS15 (2)	60 amp (2)	50 amp (2)	115 v reg 115 v reg 230 v reg	3.4	7
115 v 3ph	4-wire Wye	1570-ALS15 (3)	60 amp (3)	50 amp (3)	115 v 3ph reg	3.5.1	8
115 v 3ph	Delta	1570-ALS15* (3)	60 amp (3)	50 amp (3)	115 v 3ph reg	3.5.2	9
230 v 3ph	4-wire Wye	1570-AHS15† (3)	25 amp (3)	20 amp (3)	230 v 3ph reg	3.6.2	8
230 v 3ph	Delta	1570-AHS15†* (3)	25 amp (3)	20 amp (3)	230 v 3ph reg	3.6.3	9
115 v	For uninterrupted power	1570-ALS15 (1)	60 amp (1)	50 amp (1)	115 v reg or unreg	3.7	11
230 v balanced 3-wire	For uninterrupted power	1570-AHS15 (1)	25 amp (2)	20 amp (2)	230 v reg or unreg	3.7	12

NOTES:

* - modified per paragraph 3.5.2.

† - modified per Table 2.

Fuse ratings are for normal ±10% correction range.
For ±20% range, fuse ratings may be halved.

3-5-58

1570-AS20

INSTRUCTION SHEET

1570-AS20 is the same as 1570-ALS15 except:

1. Panels are omitted from each unit.
2. On-off switch is omitted.
3. 50-60~ switch is omitted and instrument is wired for 60~ only.
4. T 2 and T 3 may be 345-468

1570-20SF-6D

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OPERATING AND MAINTENANCE
INSTRUCTIONS

TYPE 1570-AS15 AUTOMATIC LINE-VOLTAGE REGULATOR

Form 963-A
April, 1957

GENERAL RADIO COMPANY

275 MASSACHUSETTS AVENUE

CAMBRIDGE 39 MASSACHUSETTS

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Printed in U.S.A.

SPECIFICATIONS

OUTPUT VOLTAGE RANGE: ±10% of base value of 115 or 230 volts.

INPUT VOLTAGE RANGE: Nominal correction ranges of ±10% and ±20% are available. Instruments are shipped with the ±10% range unless the ±20% range is specified on order. Exact ranges are given in the table below.

OUTPUT VOLTAGE	115 v (nominal) adjustable ±10%		230 v (nominal) adjustable ±10%	
NOMINAL CORRECTION RANGE	±10%	±20%	±10%	±20%
INPUT VOLTAGE RANGE WITH 115- or 230-V OUTPUT*	105-125 v	96-138 v	210-250 v	192-276 v
OUTPUT CURRENT - AMP	50	25	20	10
KVA - APPROX	6	3	5	2.5
ACCURACY IN % OF OUTPUT VOLTAGE	0.25	0.5	0.25	0.5
SPEED OF RESPONSE VOLTS/SEC**	10	20	20	40

*For output voltages other than 115 or 230 volts, the input voltage range is from 91.3 to 108.7% of the output voltage for the ±10% correction range; 83.5 to 120% for the ±20% range. (See Figure 10.)

**Slightly less for very small voltage corrections.

WAVEFORM DISTORTION: No distortion. Output waveform same as input.

WAVEFORM ERROR: The voltage sensing device responds to the average value of the rectified output voltage. Therefore, the average value of the output voltage is held constant, and a loaded d-c power supply operated from the regulator output will give constant output voltage regardless of the harmonic distortion present in the power line. The rms output voltage will also remain constant regardless of the harmonic distortion present as long as the phase and amplitude of the harmonics are constant. If the harmonic content changes, the rms value will change by an amount less than $\Delta R/n$, where ΔR is the change in the harmonic amplitude and n is the harmonic number.

EFFICIENCY: 98%

AMBIENT TEMPERATURE: Operating: -29° to +52°C
Storage: -54° to +54°C

FREQUENCY: 45-55 or 55-65 cps, switch-selected.

POWER CONSUMPTION: 35 watts no load, 100 watts full load.

MOUNTING: Relay rack

MILITARY SPECIFICATION: Instrument designed in accordance with Spec MIL-E-4158A.

DIMENSIONS:

	Regulator Unit	Control Unit
Height	7 in.	3½ in.
Width	19 in.	19 in.
Depth	11¼ in.	8½ in.
Weight	50 lb	13¾ lb

GENERAL RADIO EXPERIMENTER reference: Volume 31, No. 6, November 1956.

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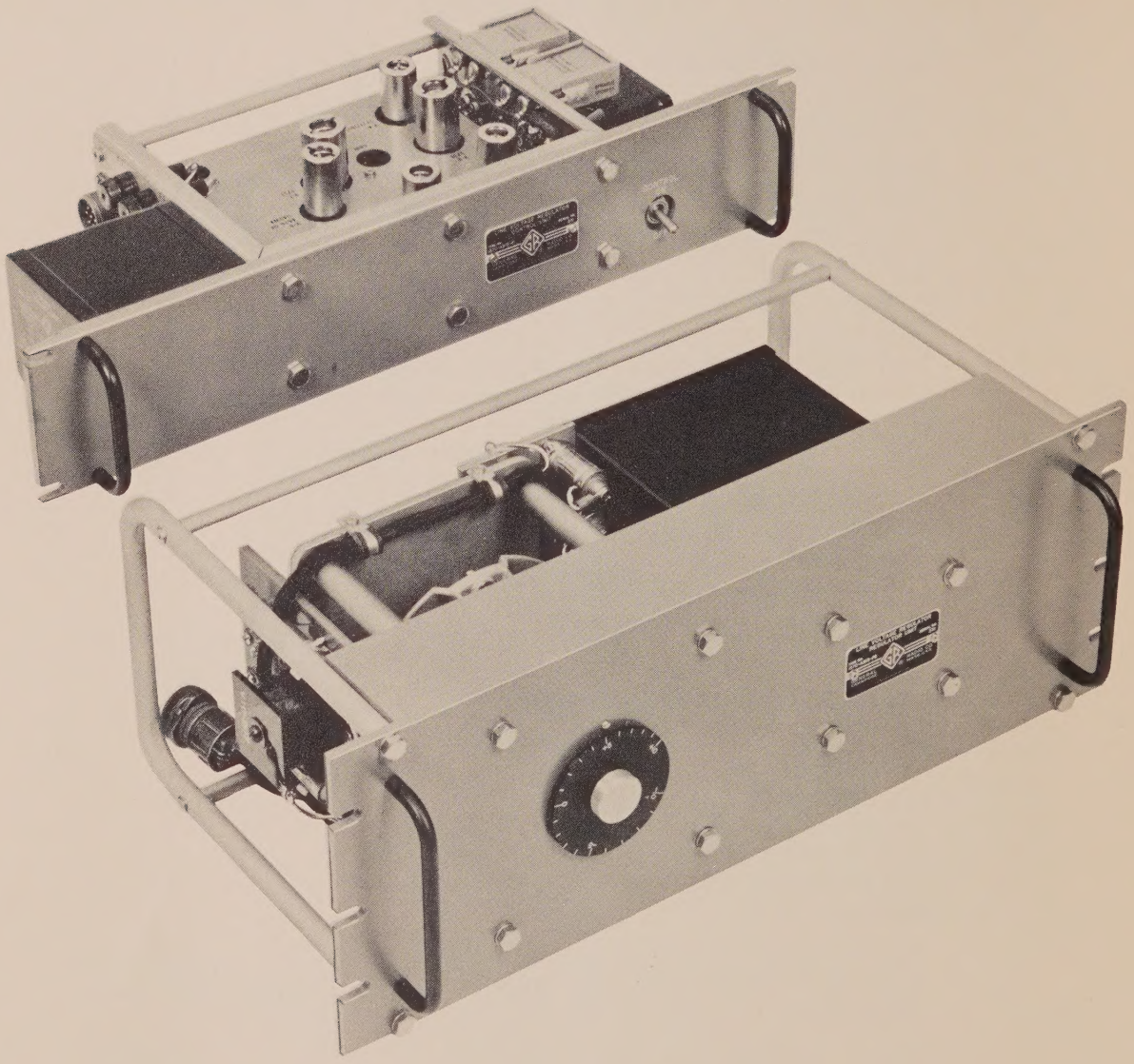


Figure 1. Type 1570-AS15 Automatic Line-Voltage Regulator.

TYPE 1570-AS15

AUTOMATIC LINE-VOLTAGE REGULATOR

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1570-AS15 Automatic Line-Voltage Regulator (Figure 1) is a high-speed electromechanical regulator, which provides constant output voltage at a predetermined level. Use of the Type 1570-AS15 Regulator yields an accurate constant voltage for supplying large loads independent of load power factor and without harmonic distortion.

The Regulator is available in either of two models: Type 1570-ALS15 for 115-volt service or Type 1570-AHS15 for 230-volt use.

1.2 DESCRIPTION.

1.2.1 GENERAL. The Type 1570-AS15 Automatic Line-Voltage Regulator comprises two basic components: a regulator unit and a control unit. The regulator unit contains a motor-driven Variac® for voltage adjustment and a "buck or boost" step-down transformer, which effectively multiplies the power rating of the Variac. The control unit operates the servo motor on the Variac.

1.2.2 CONTROLS.

1.2.2.1 Control Unit. The CONTROL toggle switch on the panel of the control unit operates the servo amplifier. With this control in the ON position, the Variac is automatically adjusted to maintain constant voltage regardless of load variations or input voltage fluctuations. With the switch in the OFF position, power is removed from the servo amplifier, permitting manual control of the output voltage by rotation of the dial on the panel of the regulator unit.

Also on the control unit is a two-position toggle switch by which either 50- or 60-cycle operation can be selected. The 50-cps position should be used for inputs between 45 and 55 cps, and the 60-cps position for inputs between 55 and 65 cps.

WARNING

The CONTROL switch does not remove power from the regulator unit, nor from any load connected to the regulator.

1.2.2.2 Regulator Unit. The dial on the regulator unit serves two purposes: it indicates the voltage deviation for which correction is being applied, and, with the CONTROL switch OFF, permits manual adjustment of output voltage. The dial is calibrated in units from -10 to +10 that roughly correspond (on models with a ±10-percent range) to percent or volts deviation of the input voltage from the desired output voltage. On 20-percent models the dial indications should be doubled to indicate deviation. The approximate calibration denotes the available correction range of the regulator.

Section 2
THEORY OF OPERATION

2.1 GENERAL. (See Figure 2.) The a-c output of the regulator is measured by a full-wave silicon-junction rectifier. Voltage from the rectifier is filtered and then compared with a standard voltage from a Type 5651 voltage-reference tube to obtain an error voltage. The error voltage is applied, through a two-stage balanced amplifier, to a thyratron circuit. The thyratrons control the low-inertia, two-phase servo motor that

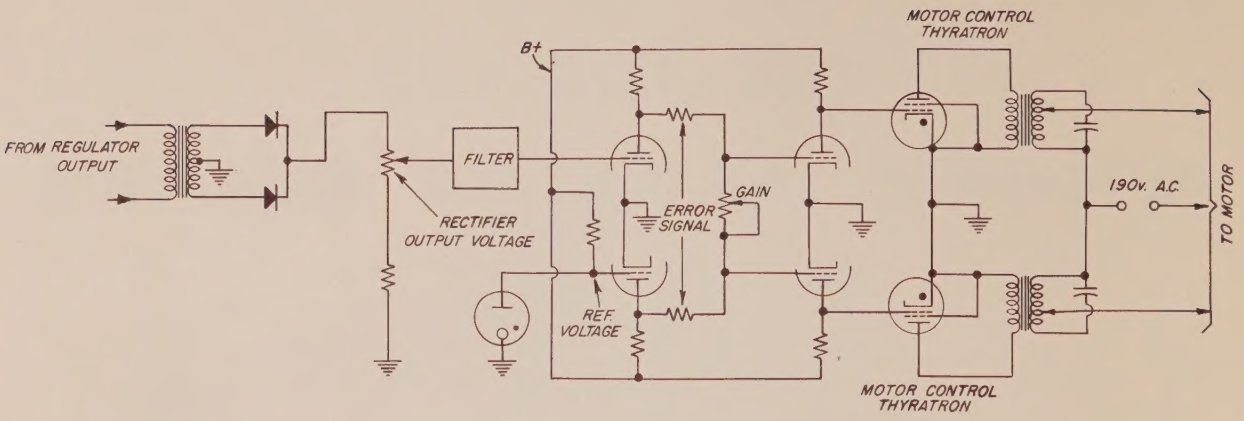


Figure 2. Elementary Schematic Diagram of Control Unit

positions the Variac. The Variac, through a step-down transformer, adjusts the voltage added to or subtracted from the input, thus providing a constant output voltage.

2.2 VOLTAGE-ADJUSTING SYSTEM. By means of the "buck or boost" circuit (Figure 3), a large amount of power can be controlled by a Variac of considerably smaller power. The auxiliary transformer uses multiple windings to provide either a ±10-percent or ±20-percent correction range at 115 or 230 volts. (A ±5-percent range is also possible at 230 volts; refer to diagram on Figure 13b). The Duratrak contact surface of the special ball-bearing Variac provides a stable brush track capable of withstanding severe overloads, while the ball bearings minimize friction, thereby extending the life of a system demanding continual motion.

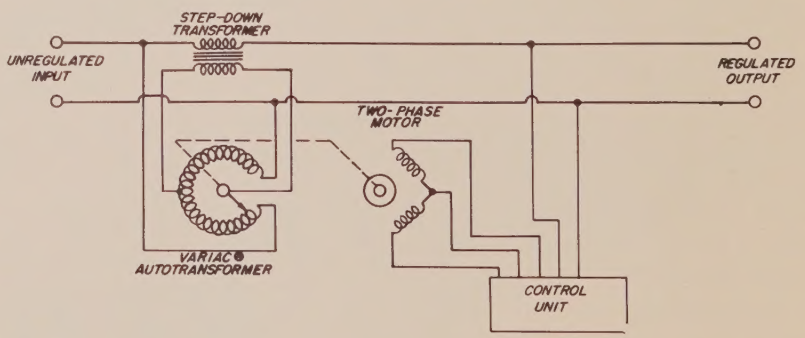


Figure 3.
Functional Diagram of
Buck-or-Boost Circuit

2.3 CONTROL CIRCUIT. The regulated output voltage is measured by an average-response full-wave rectifier to obtain a d-c voltage proportional to the a-c output voltage. Average response is effected by the purely resistive load on the rectifier. Silicon junction diodes are used to provide high efficiency and to minimize any effect of changing rectifier characteristics. The rectifier is full-wave, so that the ripple frequency is well beyond the pass band of the regulator. The ripple filter provides considerable rejection from 90 to 130 cycles, with small phase shift below 5 cps.

The filtered voltage is compared with a standard voltage from a Type 5651 voltage reference tube, and the difference between these voltages is ultimately used to reposition the Variac.

The amplified error voltage is applied in push-pull to a thyratron motor control circuit. The 60-cycle thyratron bias voltage is at a 90-degree phase angle with respect to the a-c plate voltage. The amplified d-c error voltage is superimposed on this a-c bias voltage to vary the thyratron firing angle from 0 to almost 180 degrees.

The two-phase motor receives power from the 60-cycle line through the thyratron control circuit. By a push-pull variation in firing angle, the thyratrons control the relative phase between the motor winding voltages. The thyratron transformers provide filtering as well as impedance matching. As the thyratron firing angle changes from 0 to almost 180 degrees, the angle between the motor voltages changes continuously from approximately +90 to -90 degrees. At balance, full voltage is applied to both motor windings at a zero-degree phase angle. The resultant dynamic braking improves the transient response.

Section 3
INSTALLATION

3.1 GENERAL. Although the Type 1570-AS15 Automatic Line-Voltage Regulator is designed primarily for permanent installation (and will be so treated herein), the instrument is readily adaptable to portable use. Line cords of the type used with electric ranges may be used in such installations. In all installations, suitable fuses and disconnect switches should be used (refer to Table 1). Note that when the input voltage is 10 or 20 percent less than the desired output voltage the input current will be 10 or 20 percent greater than the output current. Therefore, input fuses should be of higher rating than output fuses.

Mounting holes on the Regulator Unit are 5/16-in., so that 1/4-in. bolts can be used to attach the 50-lb unit to the relay rack, if desired. Standard mounting hardware can also be used to fit standard tapped holes in the relay rack.

TABLE 1
FUSES AND DISCONNECT SWITCHES

	1570-ALS (115v) (Figure 4)		1570-AHS (230v) (Figure 5)	
Correction Range	±10%	±20%	±10%	±20%
Disconnect Switch	60 amp	30 amp	30 amp	15 amp
Input Fuse	60 amp	30 amp	25 amp	15 amp
Output Fuse	50 amp	25 amp	20 amp	10 amp

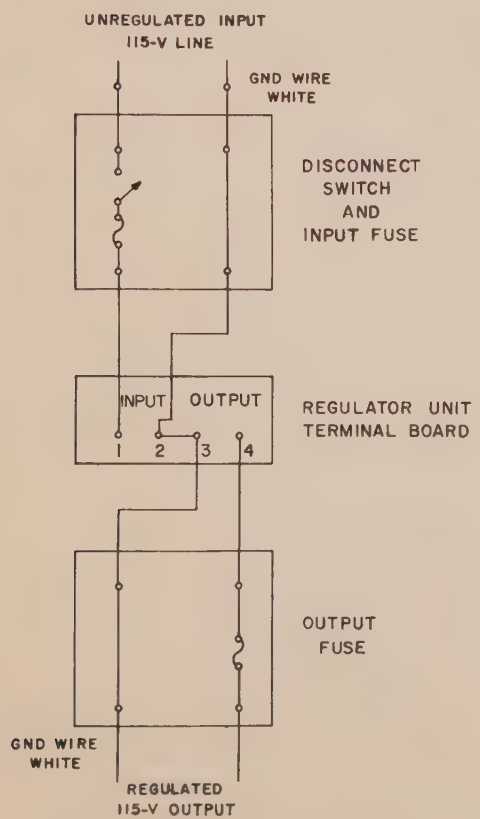


Figure 4. Connection Diagram, Type 1570-ALS15 Regulator

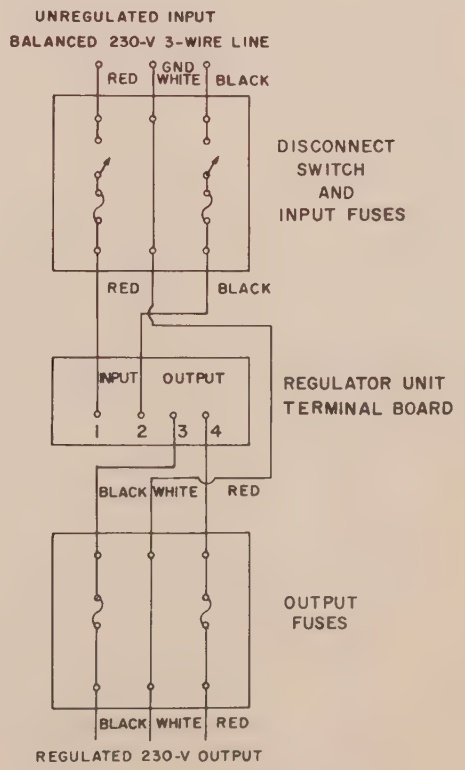


Figure 5. Connection Diagram, Type 1570-AHS15 Regulator

3.2 NORMAL CONNECTIONS FOR 115- AND 230-VOLT OPERATION. Figures 4 and 5 show the proper connections of Type 1570-ALS15 (115-volt) and 1570-AHS15 (230-volt) Regulators for normal operation. Suitable fuses and disconnect switch, as listed in Table 1, should be provided.

The Type 1570-AHS15 Regulator applies balanced corrections to both sides of a balanced, three-wire, 230-volt line. However, while the 230-volt supply is regulated, each side to neutral (115 volts) is not necessarily regulated; this depends on input voltage and output load balance (refer to paragraph 3.4). For regulation of 230-volt lines with one side ground or neutral refer to paragraph 3.6.1.

3.3 USE OF A TYPE 1570-ALS15 REGULATOR TO REGULATE ONE SIDE OF A BALANCED 230-VOLT LINE. It is often desirable to distribute both regulated and unregulated power. One side of a three-wire, 230-volt system can be regulated by connection of a Type 1570-ALS15 Regulator as shown in Figure 6. With this connection, regulated power is available on one side of the line to neutral, while the other side of the line to neutral and the 230-volt line-to-line power are unregulated. For proper sizes of fuses and disconnect switch, refer to Table 1.

3.4 USE OF TWO TYPE 1570-ALS15 REGULATORS TO REGULATE BOTH SIDES OF A BALANCED 230-VOLT LINE. If each line to neutral (115 volts) as well as the line to line (230 volts) must be regulated, connect two Type 1570-ALS15 Regulators as shown in Figure 7. With this connection, each Regulator maintains one side of the output line constant with respect to neutral. Thus, a balanced output is obtained regardless of any unbalance in the input voltage or the output load. The 230-volt line-to-line voltage is also maintained constant, so that there are two regulated 115-volt lines and one regulated 230-volt line available. For proper sizes of fuses and disconnect switch, refer to Table 1.

3.5 115-VOLT THREE-PHASE CONNECTIONS.

3.5.1 FOUR-WIRE WYE CONNECTION, 115 VOLTS EACH WIRE TO NEUTRAL. Three Type 1570-ALS15 Regulators can be connected as shown in Figure 8 to provide this type of regulation. Note that while each wire to neutral is regulated, the 208 volts line to line is not necessarily regulated. For proper sizes of fuses and disconnect switch, refer to Table 1.

3.5.2 DELTA CONNECTION, 115 VOLTS LINE TO LINE. To operate three Type 1570-ALS15 Regulators in a closed delta, the following wiring changes are necessary:

a. Remove from each control unit the grey-brown lead running between fuse F1 and pin A of connector J1.

b. Run a lead from fuse F1 of each control unit to pin A, connector J1 of the adjacent control unit as shown in Figure 9.

After the above modifications, the Regulators may be connected as shown in Figure 9. Proper sizes of fuses and disconnect switch are listed in Table 1.

3.6 208-VOLT AND 230-VOLT THREE-PHASE CONNECTIONS.

3.6.1 GENERAL. For 230-volt three-phase operation, a balanced correction on each side of the input line is not possible. A minor wiring change is necessary on the Type 1570-AHS15 Regulator so that full correction voltage can be applied to one side of the line. Table 2 lists the changes necessary to adapt the Type 1570-AHS15 Regulator for three-phase operation. While the output voltage is normally set to 230 volts, the output voltage adjustment (R5) has sufficient range to permit setting the output voltage to 208 volts. The Regulator

TABLE 2 208/230-VOLT, 3-PHASE CONNECTIONS

OUTPUT			CONNECTIONS		
AMP	KVA	Range	T4 Primary	T4 Secondary	TB1
40	10	±5%	2-3	5-6-7-8 . . . 1 9-10-11-12 . 4	2-3
20	5	±10%	2-3	5-6 . . . . 1 7-8-9-10 11-12. . . . 4	2-3
10	2.5	±20%	2-3	5 . . . . . 1 6-9 7-10 8-11 12. 4	2-3

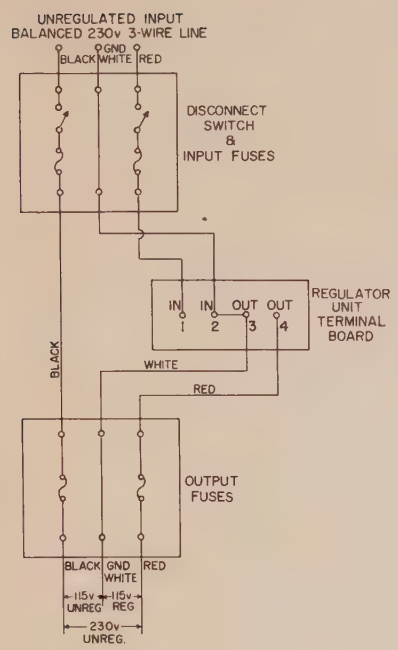


Figure 6. Connection of a Type 1570-ALS15 Regulator to Regulate One Side of a Balanced 230-Volt Line

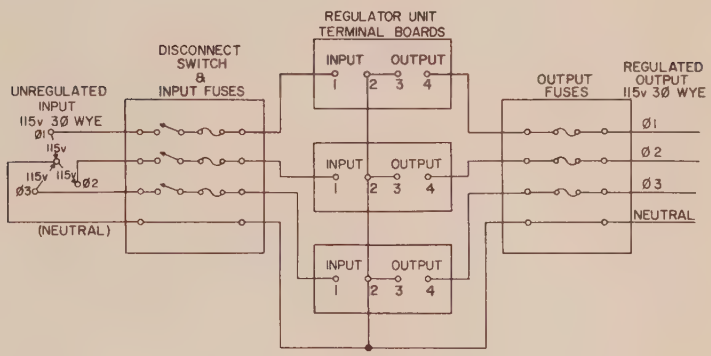


Figure 8. Four-Wire Wye Connection, 115 Volts Each Wire to Neutral

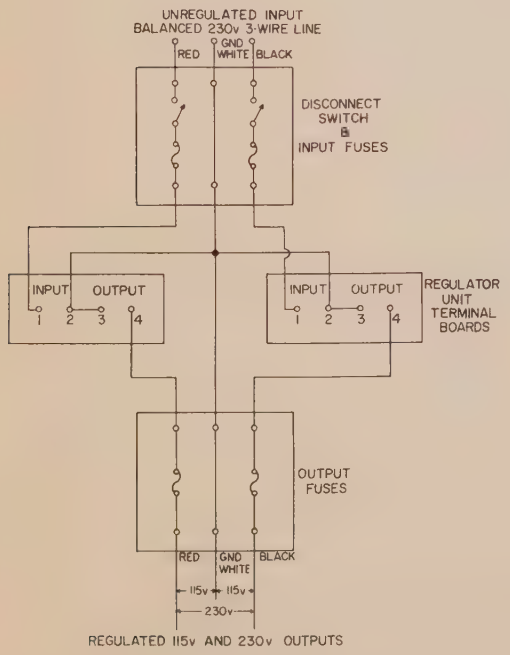


Figure 7. Connection of Two Type 1570-ALS15 Regulators to Regulate Both Sides of a Balanced 230-Volt Line

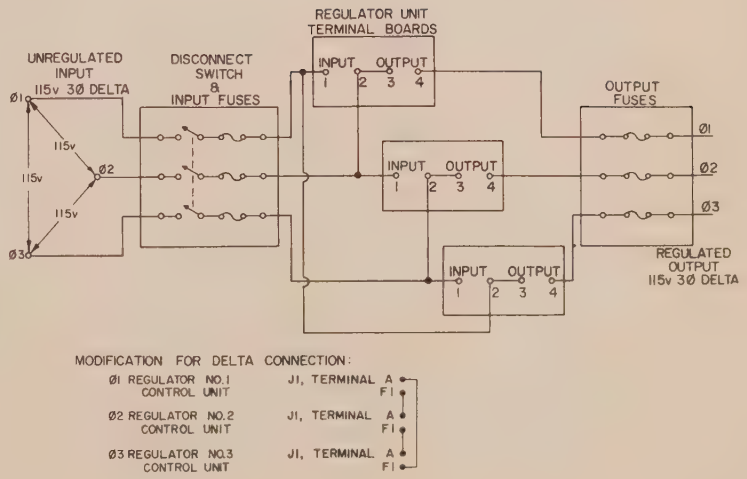


Figure 9.
Delta Connection, 115 Volts Line to Line

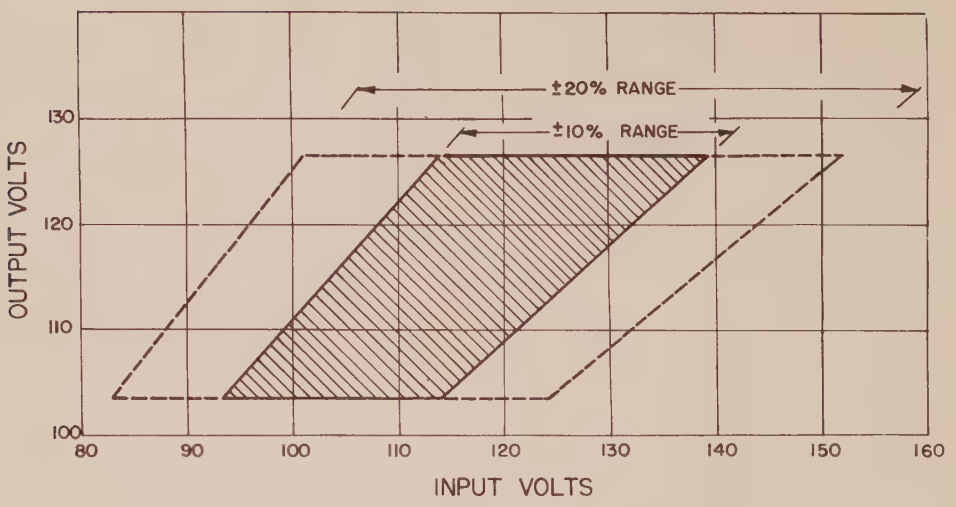


Figure 10. Range of Operation for 115-Volt Model (for 230-volt model, multiply voltage scale by two).

will still operate normally as the input voltage varies by ±10 percent or ±20 percent from 208 volts. (See Figure 10.)

3.6.2 FOUR-WIRE WYE CONNECTION, 230 VOLTS EACH WIRE TO NEUTRAL. After modification in accordance with Table 2, three Type 1570-AHS15 Regulators can be connected in the manner illustrated in Figure 8. Note that while each line to neutral is regulated, the line-to-line voltage is not necessarily regulated. For proper sizes of fuses and disconnect switch, refer to Table 1.

3.6.3 DELTA CONNECTION, 208 OR 230 VOLTS LINE TO LINE. For a 208- or 230-volt delta connection of three Type 1570-AHS15 Regulators, two modifications must be made. First, modify the regulator units as described in paragraph 3.6.1 and Table 2. Then modify each control unit according to paragraph 3.5.2. For proper sizes of fuses and disconnect switch, refer to Table 1.

3.7 CONNECTION WHERE INTERRUPTION OF POWER FOR ROUTINE MAINTENANCE IS NOT DESIRABLE. In applications where interruption of power for routine maintenance is undesirable, the Type 1570-AS15 Automatic Line-Voltage Regulator can be connected so that it can be removed without interruption of power. An additional output switch (see Figures 11 and 12) will permit removal of the regulator without interruption of power. The output switch is normally in the regulated position and the regulator disconnect switch is on. To remove the regulator from the circuit without interrupting the flow of power, proceed as follows:

a. Set the toggle switch on the control unit to the OFF position, so that the motor is inoperative.

b. Rotate the input voltage dial on the regulator unit to zero to reduce the voltage across the output switch to zero.

c. Place the output switch (see Figures 11 and 12) in the unregulated position. This transfers the flow of current from the regulator to the output switch.

d. Turn the regulator disconnect switch off. This removes all voltage from the regulator.

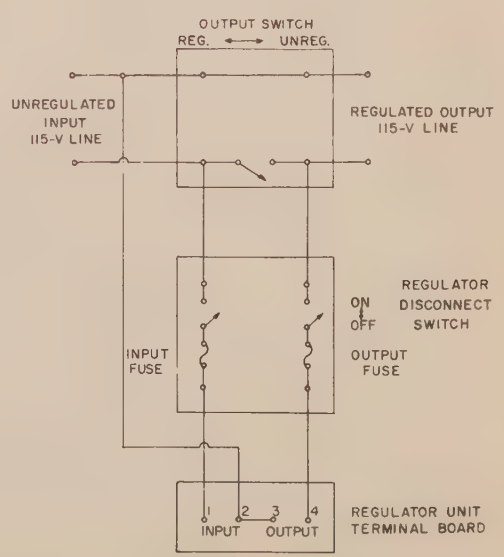


Figure 11. Connection Diagram, Type 1570-ALS15, Interruption of Power Not Desirable

To return the regulator to service:

a. Make sure that the toggle switch on the control unit is in the OFF position.

b. Rotate the input voltage dial on the regulator unit to zero.

c. Turn the regulator disconnect switch (see Figures 11 and 12) on.

d. Set the output switch (Figures 11 and 12) to the regulated position.

e. Set the toggle switch on the control unit to the ON position. As soon as the vacuum tubes warm up, the output will again be regulated.

3.8 CHANGE OF CORRECTION RANGE. Figures 13a and 13b (pages 11 and 12) show the connections for the "buck or boost" transformer for various correction ranges. The speed of correction and the correction accuracy are affected by the correction range (refer to Specifications). The tag on the rear of the regulator can be altered to indicate the proper correction range.

NOTE

The Type 1570-ALS15 Regulator cannot be changed to a Type 1570-AHS15 by a simple wiring change; Variacs of different voltage ratings are used in the two models.

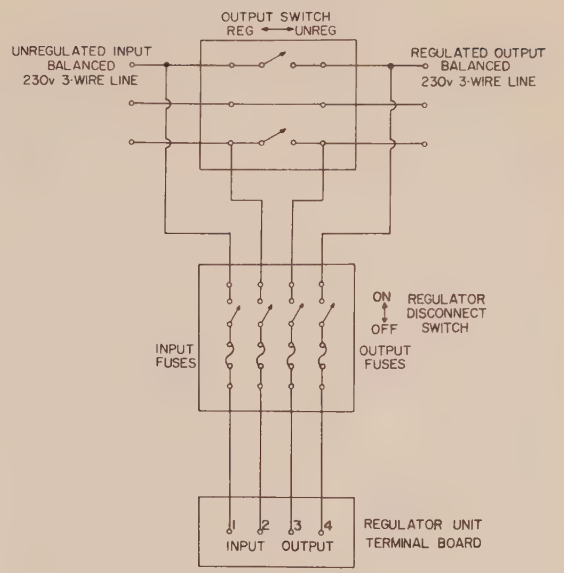


Figure 12.
Connection Diagram, Type 1570-AHS15,
Interruption of Power Not Desirable

Section 4
OPERATING PROCEDURE

4.1 GENERAL. The Type 1570-ALS15 Automatic Line-Voltage Regulator is a fully automatic instrument, and requires no external control during operation other than the proper selection of frequency range by means of the 50-60-cps toggle switch on the control unit chassis.

4.2 MANUAL OPERATION. The control unit CONTROL ON-OFF switch permits use of either regulated or unregulated power. It does not shut off the output of the regulator, but merely turns on or off the control unit that operates the Variac. When this switch is in the OFF position, the output voltage can be varied manually by means of the dial on the front of the regulator. When this dial is at zero, the output voltage will be nearly equal to the input voltage.

Section 5
SERVICE AND MAINTENANCE

5.1 GENERAL. This service information should enable the user to locate and correct ordinary difficulties resulting from normal use. Major service problems should be referred to our Service Department, which will cooperate as much as possible by furnishing information and instructions as well as by supplying any replacement parts needed.

When notifying our Service Department of any difficulties in the operation of the instrument, always mention the serial and type numbers of the instrument. Also include a report of trouble encountered, as well as information concerning the use of the instrument and steps taken to remedy the trouble. Before returning an instrument for repair, please write to our Service Department, requesting a Returned Material Tag, which includes shipping instructions. A purchase order covering repair of material returned should also be forwarded to avoid unnecessary delay.

5.2 DISASSEMBLY. Tubes may be removed and replaced without removal of the top cover plate. To gain access to the component (top) side of the etched board, it is necessary to remove the top cover plate. This plate is attached by five 6-32 screws, one at each corner and one in the center. After removal of all tubes and of these screws, the plate may be withdrawn to the rear of the unit.

To gain access to the wiring (bottom) side of the etched board, the bottom piece must be removed. Of the 11 screws visible on the bottom piece, only seven should be removed. These are the six larger (10-32) screws at the corners and the 6-32 screw in the center. The other four 6-32 screws at the corners hold the etched board in place, and these should not be removed for routine maintenance.

5.3 ADJUSTMENTS.

5.3.1 OUTPUT VOLTAGE ADJUSTMENT. The output voltage can be adjusted ±10 percent from the nominal 115 (or 230) volts set at the factory by adjustment of R5 on the control unit chassis. Tube replacement (particularly of V3) or resetting of the gain control (R32) may necessitate minor readjustment of R5. Use an accurate voltmeter (preferably of the dynamometer type) to set the output voltage. The input voltage range will always be within ±10 or ±20 percent of the output voltage setting.

5.3.2 GAIN CONTROL. The gain control is inside the regulator on the control unit chassis. As this control is turned clockwise the regulator accuracy is improved, and the regulator becomes less stable. If the gain control is set too high, the motor will jump back and forth (overshoot) several times after each correction. At full gain the motor may oscillate continuously. The gain control is set at the factory so that there is just a trace of overshoot. If this is objectionable, the gain should be reduced. If slightly greater accuracy is needed and more overshoot can be tolerated, the gain may be increased.

5.3.3 FILTER. An r-c filter, with a rejection notch at 108 cycles, provides considerable ripple-voltage rejection between 90 and 130 cycles. The frequency at which the notch occurs can be shifted slightly by adjustment of R10 for a minimum of ripple voltage at the grid (pin 2) of V1 with respect to ground. This voltage, measured with a wave analyzer through a 0.01-μf blocking capacitor, should be less than 5 mv at both 100 cycles and 120 cycles. This adjustment is made at the factory, and should not be altered unless a wave analyzer is available.

5.4 MOTOR LUBRICATION.

5.4.1 GENERAL. Motors are normally lubricated at the factory with one of the lubricants listed in paragraph 5.4.2. For special applications in which other types of oil may be required, the lubricant used will be indicated by a tag on the motor. The lubrication port on the motor is sealed by a small screw. Remove this screw and apply 20 drops of oil (as denoted below) once every three months.

CAUTION

Do not change from a general-use to a military oil (or vice versa) without first flushing and draining the gearcase.

5.4.2 LUBRICANTS FOR GENERAL USE. The following lubricants are recommended for general use at ambient temperatures from -29 to +52 deg C:

Lubricant	Manufacturer
Gulfcrest C	Gulf Oil Corp.
Stanoil 35	Standard Oil Co. of Indiana

If neither of the above lubricants is available, substitute any high-quality, nondetergent, petroleum-base oil with a viscosity between 225 and 325 ssu at 100 deg F. Suitable lubricants are lathe spindle oil and nondetergent SAE 20 automotive oil. Small quantities of suitable lubricant are available from the General Radio Company Service Department.

5.4.3 LUBRICANTS MEETING MIL-L-6085A (NORMAL TEMPERATURE CONDITIONS). The following lubricants are suggested for military applications under Specification MIL-L-6085A and are recommended for operating temperatures from -29 to +52 deg C:

Lubricant	Manufacturer
Windsor Lube L-245X	F. E. Anderson Oil Co.
Univis P-38	Standard Oil Co. of New Jersey
Eclipse Pioneer P-10	Eclipse Pioneer Div., Bendix Aviation
Aero Shell Fluid 12, Code 4264	Shell Oil Co.
Cosmolubric 270	E. F. Houghton Co.
KC-85-A, L-401D	Lehigh Chemical Products Co.

5.4.4 LUBRICANTS MEETING MIL-L-7870A (LOW TEMPERATURE CONDITIONS). The following lubricants are suggested for military applications under Specification MIL-L-7870A and are recommended for operating temperatures below -29 deg C:

Lubricant	Manufacturer
Texaco Low-Temperature Oil	Texas Co.
Aviation Instrument Oil	Standard Oil Co. of New Jersey
Aero Shell Fluid 3, Code 4254	Lehigh Chemical Products Co.
Gulphite Oil 6	Gulf Oil Corp.

If low-temperature oils are used at high temperatures, more frequent lubrication than normal will be required.

5.5 VARIAC MAINTENANCE. The Duratrak brush-track surface of the Variac should be cleaned periodically with a soft cloth and a safe solvent such as alcohol or "white" (nonleaded) gasoline.

CAUTION

Do not use abrasives. Abrasives may destroy the stabilized brush-track surface.

Inspect the brush assembly periodically, noting evenness of wear, and check for evidence of arcing or pitting on the brush-track surface. Excessive load current accelerates brush deterioration and damages windings. Rapid brush failure is a sure sign of overload.

Two brushes are used with the Variac; one on the brush track on the outer circumference, one on the inner take-off collar. Wear on the inner brush is unlikely, and replacement should not be necessary under normal conditions. If this brush must be replaced, be careful when tightening the holding screws, so that the brush holder does not bind and restrict the action of the brush spring.

To remove the outer brush, simply rotate the top plate to clear the retaining pins. The brush pigtail is secured by a round-head screw on the radiator plate. Proper brush insertion is indicated by a slight click or detent action as the top plate of the brush assembly is lined up beneath the retaining pins. Newly installed or reinstalled brushes should be seated for proper Variac operation. To mate brush and track, swing the brush over the abrasive side of a thin piece of crocus cloth placed on the brush track.

Outer brushes are Type VBT-2 for 115-volt models, and Type VBT-4 for 230-volt models. Inner brushes are Type VBT-5 for both 115-volt and 230-volt models.

5.6 TROUBLE SHOOTING.

5.6.1 VOLTAGE AND RESISTANCE MEASUREMENTS. Voltage and resistance values are given on the schematic diagram, Figure 14. Measurements should be made with the regulated output voltage set at 115 volts, and with an accurate vacuum-tube voltmeter.

5.6.2 DETAILED TROUBLE-SHOOTING DATA.

5.6.2.1 No Motor Torque; Variac Does Not Respond But Can Be Turned Freely By Means of Dial on Regulator Unit.

a. Check that the switch on the control unit is ON.

b. Check that the regulator unit cable is plugged into control unit.

c. Check for proper input voltage at regulator unit terminal board.

d. Check fuses on control unit.

e. Check thyratrons (V4, V5), and replace if necessary.

f. Make sure that gain control (R32) is not at zero. Turn clockwise to increase gain.

g. Check V1 and V2, and replace if necessary.

h. Measure voltages and resistances in amplifier (see Figure 14, page 13).

i. Check that motor voltages between motor terminals 1 and 2 and terminals 2 and 3 are between 115 and 135 volts ac (as measured with a rectifier-type voltmeter). If voltage is either missing or low, look for an open transformer T2 or T3.

j. Disconnect regulator unit cable from control unit and check for open motor winding. Resistance between motor terminals 1 and 3 should be 1150 ohms.

5.6.2.2 Variac at Limit of Travel, Against Stop, and Does Not Move. Full Motor Torque Prevents Rotation of Dial by Hand.

a. Check input voltage on regulator unit terminal board to determine if it is within range of regulator.

b. Check that Variac brush is in contact with track.

c. Check thyratrons (V4, V5), and replace if necessary.

d. Check V1, V2, V3, and V6, and replace if necessary.

e. Readjust R5. (Refer to paragraph 5.3.1.)

f. Remove thyratrons V4 and V5. If the Variac still cannot be turned freely by hand, the difficulty is in the motor circuit. Check C13, C14, T2, and T3 for open or short circuits. If the Variac turns freely with V4 and V5 removed, the difficulty is in the reference, filter, or amplifier circuit. Remove the control unit bottom plate (refer to paragraph 5.2) and check the reference circuit by measuring the voltage at the grid (pin 2) of V1. This should be 43 ±3 volts. If the reference voltage is correct, check the filter circuit as follows: Remove V1 and set the dial on the regulator unit to zero. Then, with 115-volt a-c input, measure the voltage at the grid (pin 7) of V1. Adjustment of R5 should cause the voltage to vary from 37 to 49 volts. If the voltage is not within this range, check CR3, CR4, R5, R6, and the filter-circuit components.

To check the amplifier, remove V1 and measure the grid and plate voltages on V2. These should be +28 and +113 volts, respectively. If these voltages are incorrect or unbalanced by more than 15 volts plate to plate on V2, locate a faulty resistor in the grid or plate circuit of V1 or V2.

g. If all above voltages are correct, check the a-c bias network (R26, R27, C15, and C16).

5.6.2.3 Poor Accuracy; Variac Behaves Sluggishly or Irregularly in Either or Both Directions of Rotation.

a. Replace thyratrons (V4, V5).

b. Check V1 and V2 for balance between sections.

c. Advance gain control clockwise.

d. Remove dust cover and check the a-c bias network (R26, R27, C15, and C16) for a defective component.

e. Remove the bottom cover plate (refer to paragraph 5.2) and measure voltages to locate faulty component. To locate d-c amplifier unbalance, remove thyratrons (V4, V5) and amplifier (V1), and measure voltages as described in paragraph 5.6.2.2, step f.

f. Check the Variac brush for arcing (refer to paragraph 5.5).

5.6.2.4 Motor Oscillates or Hunts.

a. Reduce gain control for stability. (Turn control counterclockwise.) If accuracy is now poor, replace thyratrons (V4, V5).

b. Check V1 and V2 for balance between sections.

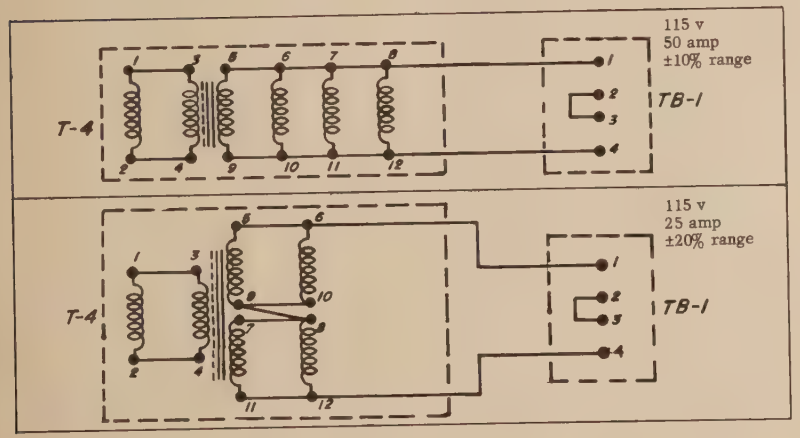
c. Check R33, C17, C11, and C12 for a defective component.

d. Check the amplifier circuits by measuring voltages as described in paragraph 5.6.2.2, step f.

PARTS LIST - 1570-ALS15 REGULATOR UNIT

REF DES	DESCRIPTION	MIL NO.
B1	MOTOR, 60cps	V10-208*
C19	CAPACITOR, 0.22μf ±10% 400dcwv	CP04A3EE224K
C20	CAPACITOR, 0.22μf ±10% 400dcwv	CP04A3EE224K
C21 to C25	CAPACITOR, 0.22μf ±40-20%, 600dcwv	1570-422*
L1	INDUCTOR	V10-207*
P1	CABLE PLUG, female	AN3106A16-1S
T4	TRANSFORMER	565-415*
T5	VARIAC, 115v	V10BBS1-2*

* General Radio Part No.



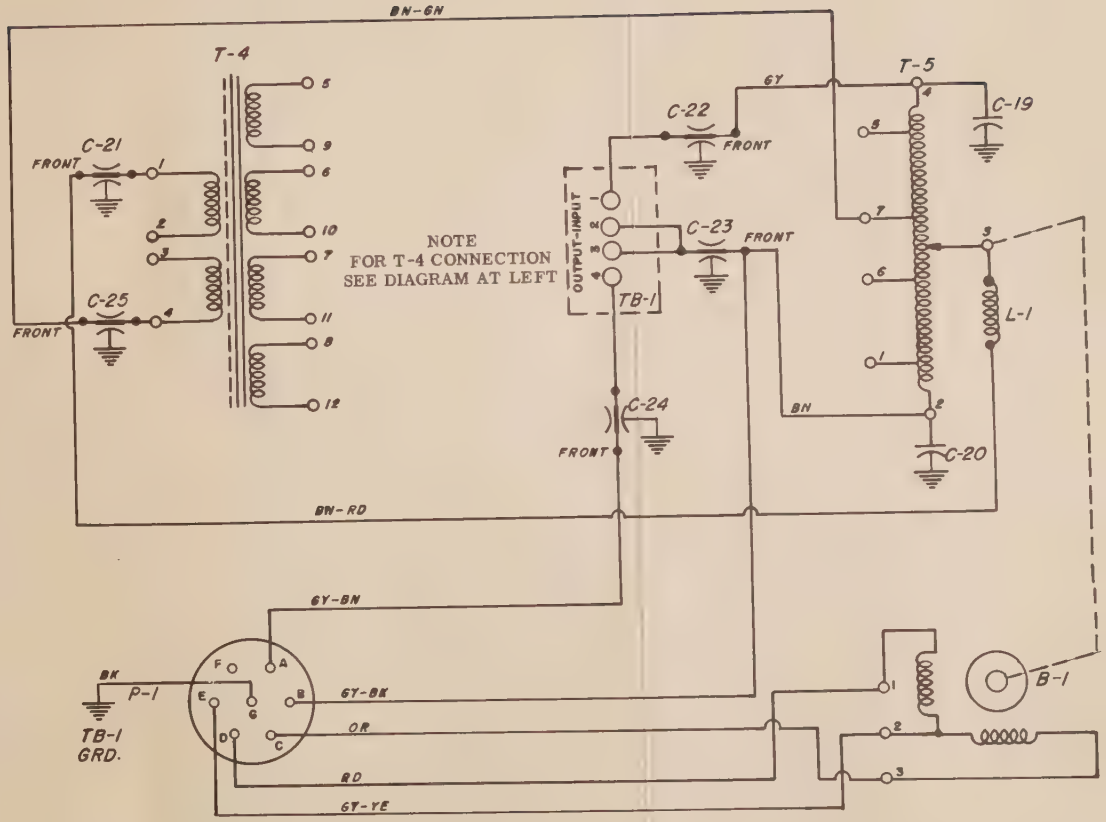


Figure 13a. Schematic Diagram for Type 1570-ALS15, Automatic Line-Voltage Regulator

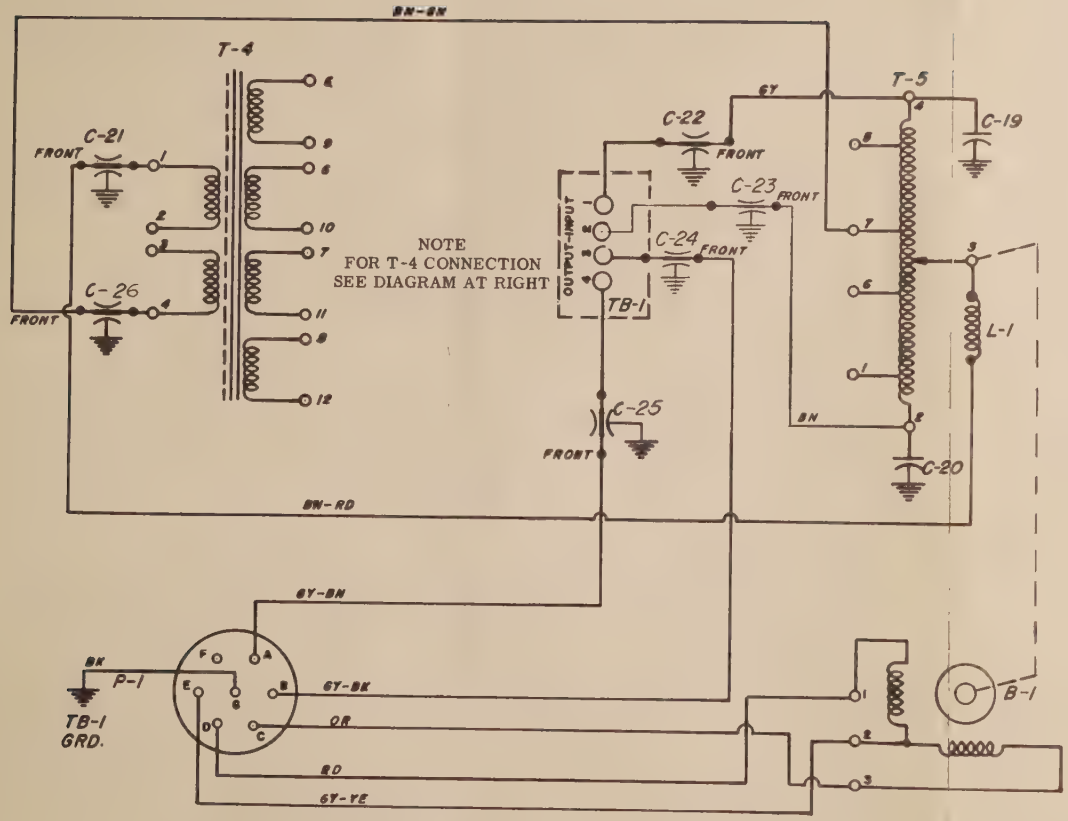
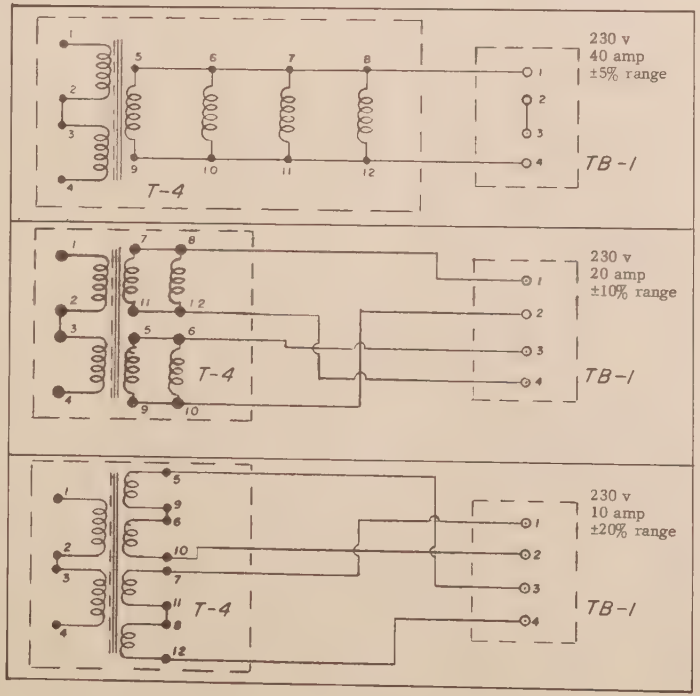


Figure 13b. Schematic Wiring Diagram for Type 1570-AHS15, Automatic Line-Voltage Regulator

PARTS LIST - 1570-AHS15 REGULATOR UNIT

REF DES	DESCRIPTION	MIL NO.
B1	MOTOR, 60cps	V10-208*
C19	CAPACITOR, 0.22μf ±10%, 400dcwv	CP04A3EE224K
C20	CAPACITOR, 0.22μf ±10%, 400dcwv	CP04A3EE224K
C21 to C26	CAPACITOR, 0.22μf +40-20%, 600dcwv	1570-422*
L1	INDUCTOR	M5-232*
P1	CABLE PLUG, female	AN3106A16-1S
T4	TRANSFORMER	565-415*
T5	VARIAC, 230v	V10HBB-S2*

* General Radio Part No.



PARTS LIST - TYPE 1570-AS15 CONTROL UNIT

	REF DES					MIL NO.
RESISTORS (NOTE A)	R3	10	k	±10%	2 w	RC42GF103K
	R4	47	k	±10%	1/2w	RC20GF473K
	R5	10	k	±10%	2 w	RA20A1SD103AK
	R6	30	k	±1%	1/3w	RB16AE30001F
	R7	1	M	±10%	1/2w	RC20GF105K
	R8	12	M	±10%	1/2w	RC20GF126K
	R9	180	k	±10%	1/2w	RC20GF184K
	R10	250	k	±10%	2 w	RV4ATSD254A
	R11	120	k	±5%	1/2w	RC20GF124J
	R12	820	k	±10%	1/2w	RC20GF824K
	R13	1	M	±10%	1/2w	RC20GF105K
	R14	1	M	±10%	1/2w	RC20GF105K
	R15	820	k	±5%	1/2w	RC20GF824J
	R16	820	k	±5%	1/2w	RC20GF824J
	R17	470	k	±10%	1/2w	RC20GF474K
	R18	4.64M		±1%	1/2w	RN70B4644F
	R19	4.64M		±1%	1/2w	RN70B4644F
	R20	100	k	±1%	1/2w	RN70A1003F
	R21	100	k	±1%	1/2w	RN70A1003F
	R22	22	k	±10%	1/2w	RC20GF223K
	R23	825	k	±1%	1/4w	RN65B8253F
	R24	1	M	±5%	1/2w	RC20GF105J
	R25	100	k	±10%	1/2w	RC20GF104K
	R26	820	k	±10%	1/2w	RC20GF824K
	R27	820	k	±10%	1/2w	RC20GF824K
	R28	150	k	±5%	1/2w	RC20GF154J
	R29	1	M	±5%	1/2w	RC20GF105J
	R30	100	k	±10%	1/2w	RC20GF104K
	R31	825	k	±1%	1/4w	RN65B8253F
	R32	500	k	±10%	2 w	RV4ATSD504A
	R33	470	k	±10%	1/2w	RC20GF474K

	REF DES					MIL NO.
CAPACITORS (NOTE B)	C1	0.68		±10%	400dcwv	CP05A3EE684K
	C2	0.33		±10%	400dcwv	CP05A3EE334K
	C4	0.1		±10%	100dcwv	CP05A3EB104K
	C5	0.1		±10%	100dcwv	CP05A3EB104K
	C6	300	µµf	±5%	500dcwv	COM-5D*
	C7	0.01		±10%	400dcwv	CP05A3EE103K
	C9	0.1		±10%	100dcwv	CP05A3EB104K
	C10	0.047		±10%	400dcwv	CP05A3EE473K
	C11	0.022		±10%	400dcwv	CP05A3EE223K
	C12	0.022		±10%	400dcwv	CP05A3EE223K
	C13	0.5		±10%	600dcwv	CP61B1EF504K
	C14	0.5		±10%	600dcwv	CP61B1EF504K
	C15	0.01		±10%	400dcwv	CP05A3EE103K
	C16	0.01		±10%	400dcwv	CP05A3EE103K
	C17	0.047		±10%	200dcwv	CP05A3EC473K
	C18	0.0082		±10%	500dcwv	CM40B822K

	REF DES		MIL NO.
MISC	CR1	RECTIFIER	SE3P20H†
	CR2	RECTIFIER	SE3P20H†
	CR3	RECTIFIER	1N352
	CR4	RECTIFIER	1N352
	F1	FUSE, 0.5 amp**	1570-418*
	F2	FUSE, 0.5 amp**	1570-418*
	J1	JACK	AN3102A16S-1P
	S1	SWITCH, dpst	MS35059-9
	S2	SWITCH, dpdt	MS35059-15
	T1	TRANSFORMER	485-490*
	T2	TRANSFORMER	345-471*
	T3	TRANSFORMER	345-471*
	V1	TUBE	5751
	V2	TUBE	5751
	V3	TUBE	5651WA
	V4	TUBE	5727/2D21W
	V5	TUBE	5727/2D21W
	V6	TUBE	6626 or OA2WA

NOTES:

(A) k = kilohm = 1000 ohms
M = megohm = 1,000,000 ohms

(B) All capacitances are in microfarads except as indicated by µµf (micromicrofarads).

* General Radio Part No.
** For 230v use 0.25-amp fuse.
† Bradley Labs. Part No.

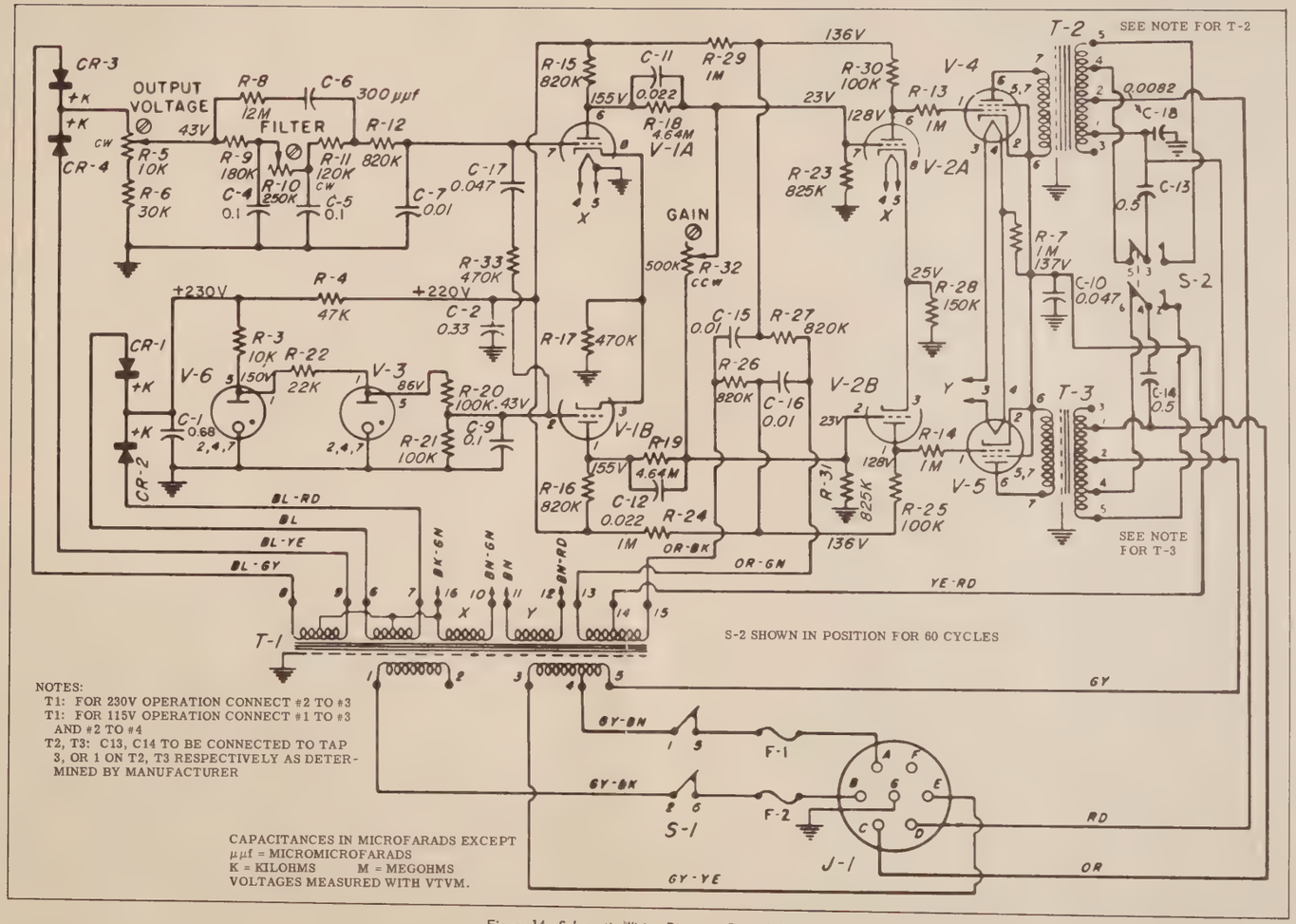


Figure 14. Schematic Wiring Diagram, Control Unit

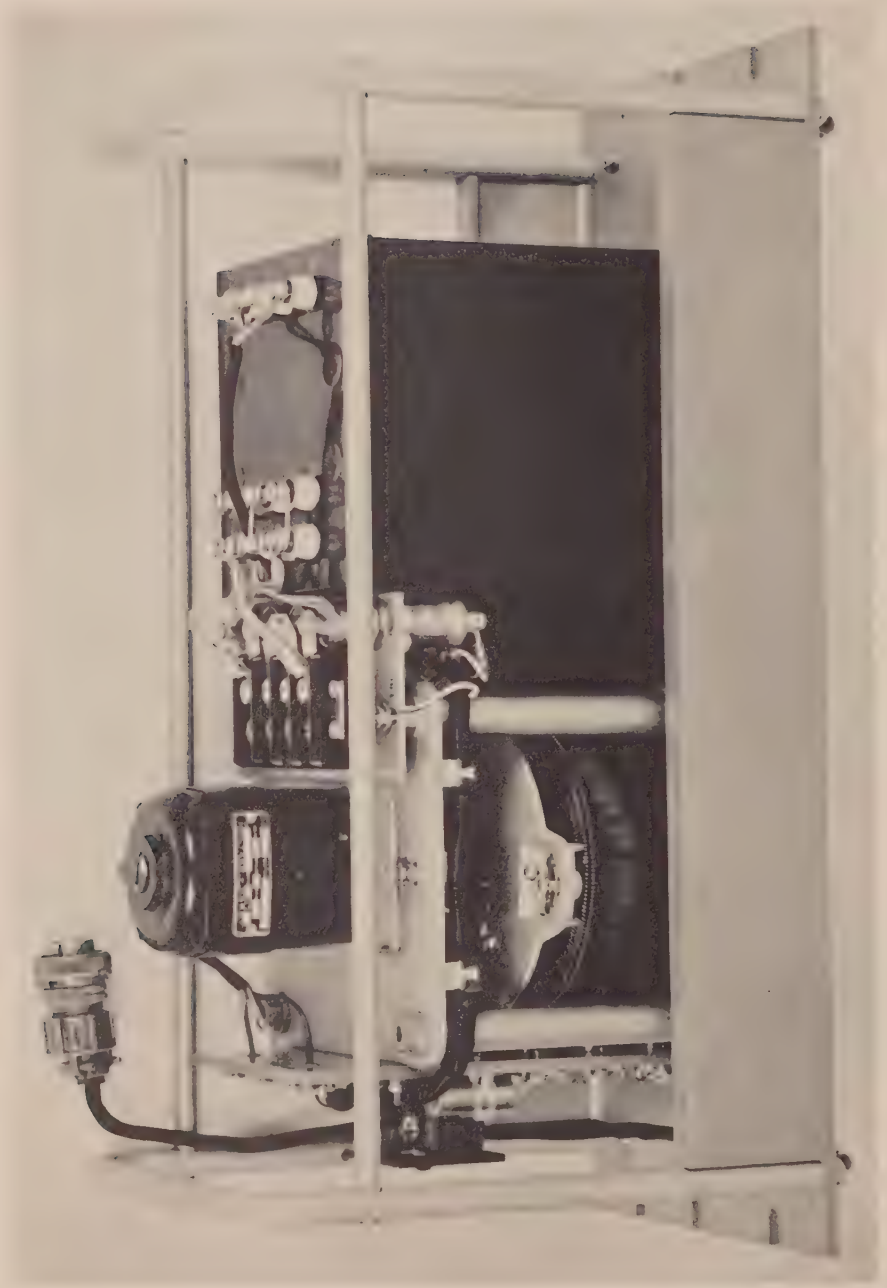


Figure 15. Rear View of Regulator Unit

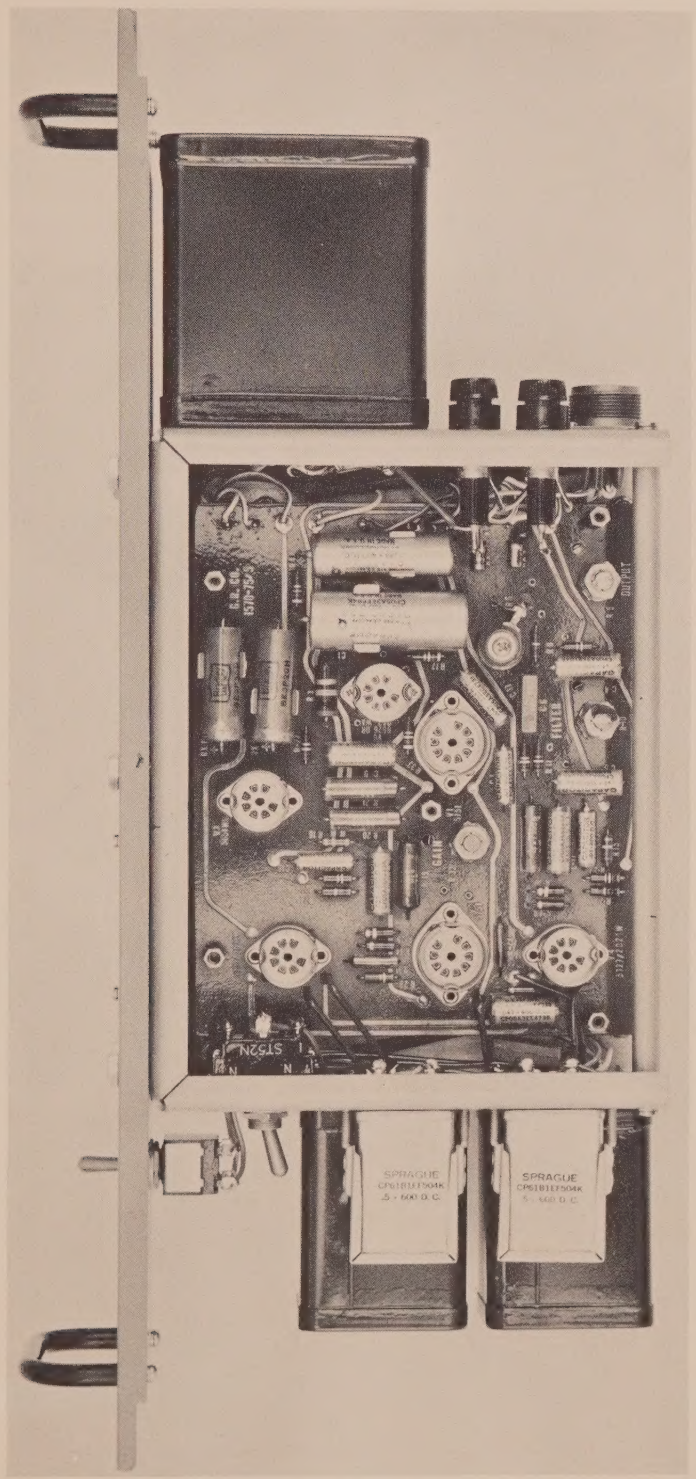


Figure 16. Top View of Control Unit, Cover Removed

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